M160™ Internet Router

PIC Guide

Juniper Networks, Inc.
1194 North Mathilda Avenue
Sunnyvale, CA 94089
USA
408-745-2000
www.juniper.net

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This guide provides an overview and description of the Physical Interface Cards (PICs) supported by the M160 Internet router. The PICs are described alphabetically.

PICs provide the physical connection to various network media types. The PICs are mounted on Flexible PIC Concentrators (FPCs), which insert into a slot in an M160 router. The FPC slots are numbered left to right, from FPC0 to FPC7. You can install up to four PICs into slots on each FPC. PICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each PIC performs framing and high-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received from the FPCs. Each PIC is equipped with a media-specific ASIC that performs control functions tailored to the PIC's media type.

A PIC occupies a single slot on an FPC. You can install PICs of different media types on the same FPC as long as the FPC and the router support those PICs. For example, you can install a four-port SONET/SDH OC-3/STM-1 PIC, a SONET/SDH OC-12/STM-4 PIC, an ATM OC-12/STM-4 PIC, and a DS-3 PIC on the same FPC of an M160 router.

A single FPC-1 has a maximum throughput of 3 Gbps and a single FPC-2 has a maximum throughput of 10 Gbps. Inserting a combination of PICs with an aggregate higher than that is supported, but constitutes oversubscription.

Blank Physical Interface Cards resemble other PICs, but do not provide any physical connection or activity. When a slot is not occupied by a PIC, you must insert a blank PIC to fill the empty slot and to ensure proper circulation of the cooling air.

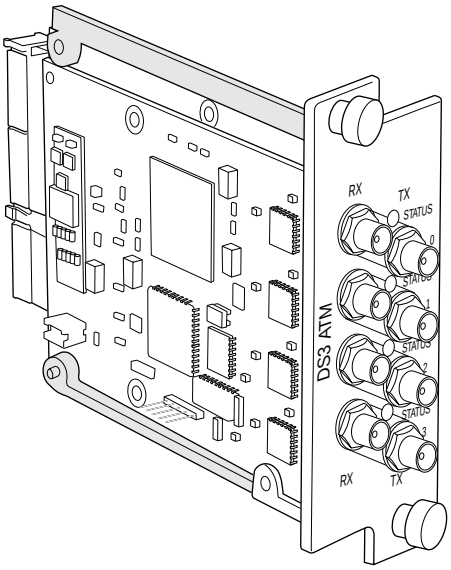
For information about installing and removing PICs, and for information about the M160 router, see the *M160 Internet Router Hardware Guide*.

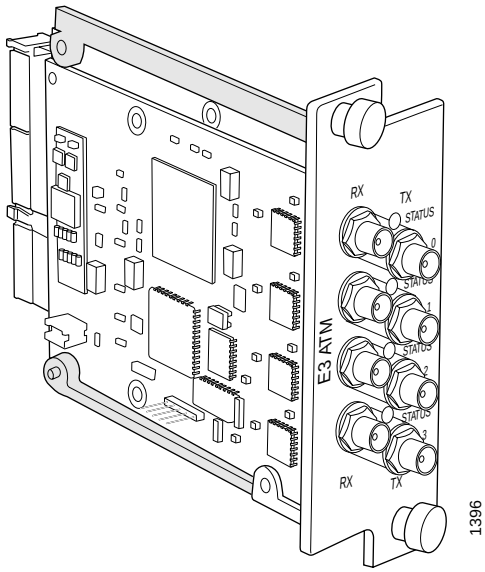
Table 1 lists the PICs supported by the M160 router.

Table 1: PICs Supported in the M160 Router

PIC Family and Type	Ports	First JUNOS Support	FPC Support and Slots Required	Page
ATM				
ATM DS-3	4	4.3	FPC1—1 slot	4
ATM E3	4	4.3	FPC1—1 slot	4
ATM OC-3	2	4.0	FPC1—1 slot	6
ATM OC-12	1	4.0	FPC1—1 slot	6
ATM2				
ATM2 OC-3	2	5.5	FPC1—1 slot	8
ATM2 OC-12	1 or 2	5.5	FPC1—1 slot	8
Channelized				
Channelized DS-3	4	4.2	FPC1—1 slot	10
Channelized DS-3 QPP	4	5.6	FPC1—1 slot	12
Channelized E1	10	5.4	FPC1—1 slot	14
Channelized E1 QPP	10	5.6	FPC1—1 slot	15
Channelized OC-12	1	4.1	FPC1—1 slot	16
Channelized OC-12 QPP	1	5.6	FPC1—1 slot	18
Channelized STM-1 to E1	1	4.4R3	FPC1—1 slot	20
Multichannel DS-3	2	5.2	FPC1—1 slot	41
DS-3, E1, E3, T1				
DS-3	4	4.1	FPC1—1 slot	22
E1	4	4.1	FPC1—1 slot	24
E3	4	4.1	FPC1—1 slot	26
T1	4	4.1	FPC1—1 slot	46
Ethernet				
Fast Ethernet	4	4.1	FPC2—1 slot	32
Fast Ethernet	8	5.2	FPC2—1 slot	32
Fast Ethernet	48	4.4	FPC2—1 slot	32
Gigabit Ethernet	1	4.0	FPC2—1 slot	34
Gigabit Ethernet	2	4.1	FPC2—1 slot	34
Gigabit Ethernet	4	5.0	FPC2—1 slot	34
10-Gigabit Ethernet	1	5.3	Entire FPC slot	38
SONET/SDH				
SONET/SDH OC-3c	4	4.0	FPC1—1 slot	42
SONET/SDH OC-12c	1	4.0	FPC1—1 slot	42
SONET/SDH OC-12c	4	4.0	FPC2—1 slot	42
SONET/SDH OC-48c	1	4.0	FPC2—1 slot	42
SONET/SDH OC-192c	1	4.0	Entire FPC slot	42
Serial				
EIA-530	2	5.6	FPC1—1 slot	28
Services PICs				
ES	0	5.3	FPC1—1 slot	30
Monitoring	0	5.4	FPC1—1 slot	40
Tunnel	0	5.3	FPC1—1 slot	47

ATM DS-3 and E3 PICs



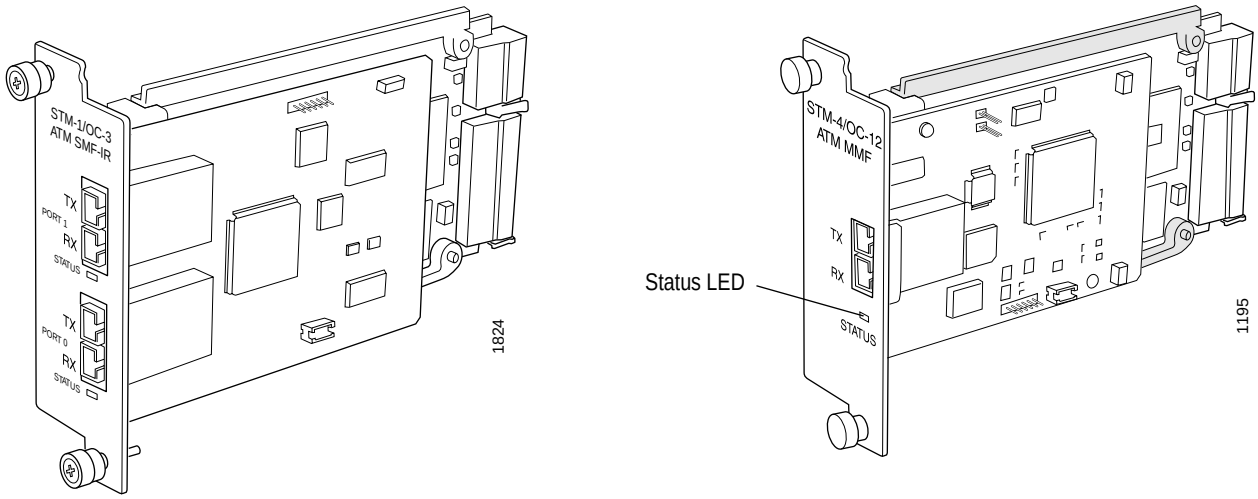


Left: ATM DS-3; Right: ATM E3

Description	■ Single-wide PIC that occupies one PIC slot ■ Four DS-3 or E3 ports ■ Power requirements: ▪ DS-3: 0.39 A/48 V = 19 W ▪ E3: 0.43 A/48 V = 20.8W ■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 ■ Asynchronous Transfer Mode (ATM) and SONET/SDH standards compliant ■ Alarm and event counting and detection ■ Compatible with well-known ATM switches ■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent FORE ATM switches
Software release	■ JUNOS 4.3 and later
Hardware features	■ OAM Fault Management processes Alarm Indication Signal (AIS) and Remote Defect Indicator (RDI) cells ■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing ■ 16-MB SDRAM memory for ATM SAR ■ Packet buffering, Layer 2 parsing
Software features	■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC) for leveraging ATM access networks ■ Support for user-configurable virtual circuits (VCs) and virtual paths (VPs) ■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC) ■ Unspecified bit rate (UBR) traffic shaping ■ Fine-grained variable bit rate (VBR) traffic shaping ■ Queues cells on a per-VC basis on the outbound PIC ■ Encapsulations—AAL5 subnetwork attachment point (SNAP)

Cables and connectors	■ 10 ft/ 3.05 m posilock SMB to BNC ■ Four pairs of TX and RX coaxial cable connectors
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	**ATM DS-3 PIC** ■ Alarm Indication Signal (AIS) ■ Far-end Block Error (FEBE) ■ Frame error ■ Idle code ■ Idle received ■ Local and remote loopback ■ Loss of signal (LOS) ■ Out of Frame (OOF) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Yellow alarm bit (X-bit) disagreements **ATM E3 PIC** ■ Alarm Indication Signal (AIS) ■ Frame error ■ Line code violation ■ Local and remote loopback ■ Loss of signal (LOS) ■ Out of Frame (OOF) ■ Yellow alarm bit (A-bit) disagreements

ATM OC-3 and OC-12 PICs



Left: ATM OC-3; Right: ATM OC-12

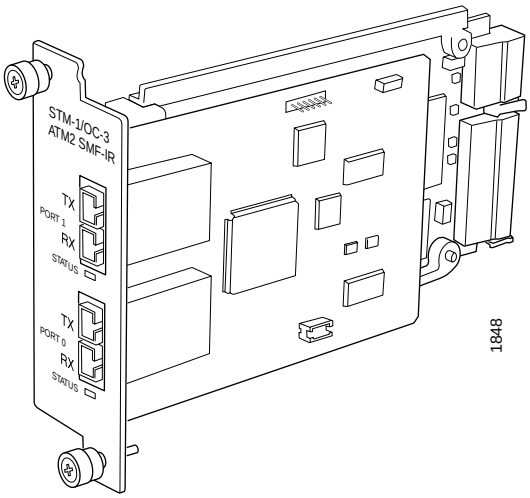
Description	■ Single-wide PIC that occupies one PIC slot ■ Two OC-3 ports or one OC-12 port ■ Power requirements: ▪ OC-3: 0.49 A/48 V = 23.7 W ▪ OC-12: 0.43 A/48 V = 20.8 W ■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 ■ ATM and SONET/SDH standards compliant ■ Alarm and event counting and detection ■ Compatible with well-known ATM switches ■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent FORE ATM switches ■ Optical interface support—See Table 2
Software release	■ JUNOS 4.0 and later
Hardware features	■ For ATM OC-3 PICs, dual 3010 SAR for segmentation and reassembly into 53-byte ATM cells ■ High-performance parsing of SONET/SDH frames ■ OAM Fault Management processes Alarm Indication Signal (AIS) and Remote Defect Indicator (RDI) cells ■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing ■ 16-MB SDRAM memory for ATM SAR ■ Packet buffering, Layer 2 parsing
Software features	■ MPLS CCC for leveraging ATM access networks ■ Support for user-configurable VCs and VPs ■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC ■ Unspecified bit rate (UBR) traffic shaping ■ Fine-grained variable bit rate (VBR) traffic shaping ■ Queues cells on a per-VC basis on the outbound PIC ■ Encapsulations—AAL5 SNAP

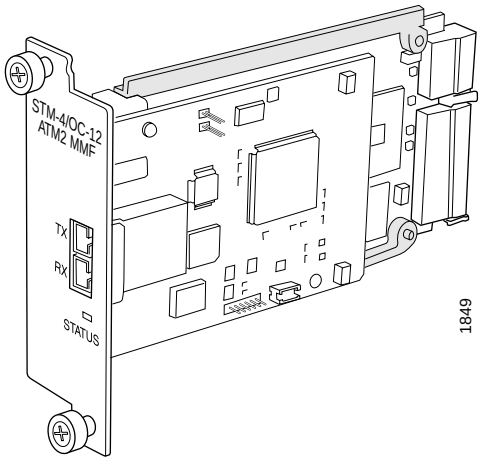
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Loss of Cell Delination (LoC), Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P)

Table 2: Optical Interface Support for ATM OC-3 and OC-12 PICs

PIC Type	Single-Mode Intermediate Reach	Multimode (62.5 Micro)
OC-3 / STM-1		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 1.2 miles/2 km), ATM Forum af-phy-0046
Wavelength	1260 through 1360 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–30 dBm
OC-12 / STM-4		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 546.8 yards/500 m)
Wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm

ATM2 OC-3 and OC-12 PICs





Left: ATM2 OC-3; Right: ATM2 OC-12

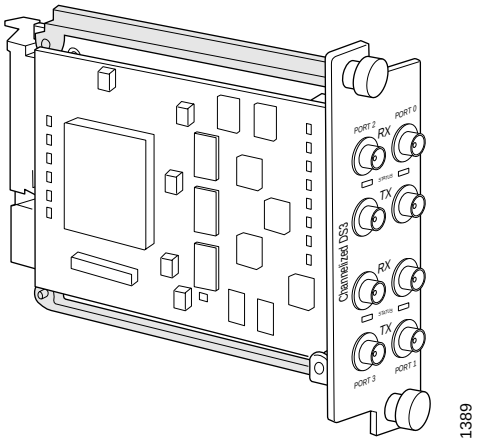
Description	■ Single-wide PIC that occupies one PIC slot ■ Two OC-3 ports or one or two OC-12 port ■ Power requirements: ▪ OC-3: 0.41 A/48 V = 20 W ▪ OC-12: 1-port–0.41 A/48 V = 20 W, 2-port–0.52 A/48 V = 25 W ■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 ■ ATM and SONET/SDH standards compliant ■ Alarm and event counting and detection ■ Compatible with well-known ATM switches ■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent FORE ATM switches ■ Optical interface support—see Table 3 on page 9
Software release	■ JUNOS 5.5 and later
Hardware features	■ ATM2 OC-3 and ATM2 1-port OC-12 PICs have one 3010 SAR for segmentation and reassembly into 53-byte ATM cells; ATM2 2-port OC-12 PICs have dual 3010 SAR ■ High-performance parsing of SONET/SDH frames ■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing ■ 64-MB SDRAM memory for ATM SAR ■ Packet buffering, Layer 2 parsing
Software features	■ MPLS CCC for leveraging ATM access networks ■ User-configurable VC and VP support ■ Support for idle cell or unassigned cell transmission ■ OAM Fault Management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI) cells, and loop cells ■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP ■ Local and remote loopback ■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC ■ Support for Simple Network Management Protocol (SNMP) management information base (MIB2), ATM MIB, and SONET MIB for each interface ■ Unspecified bit rate (UBR), non-real time variable bit rate (nrt-VBR), and constant bit rate (CBR) traffic shaping ■ Per VC or per VP shaping ■ Support for F4 OAM cells ■ Support for 16-bit VCI range

Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Loss of Cell Delination (LoC), Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P)

Table 3: Optical Interface Support for ATM2 OC-3 and OC-12 PICs

PIC Type	Single-Mode Intermediate Reach	Multimode (62.5 Micro)
OC-3 / STM-1		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 1.2 miles/2 km), ATM Forum af-phy-0046
Wavelength	1260 through 1360 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–30 dBm
OC-12 / STM-4		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 546.8 yards/500 m)
Wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm

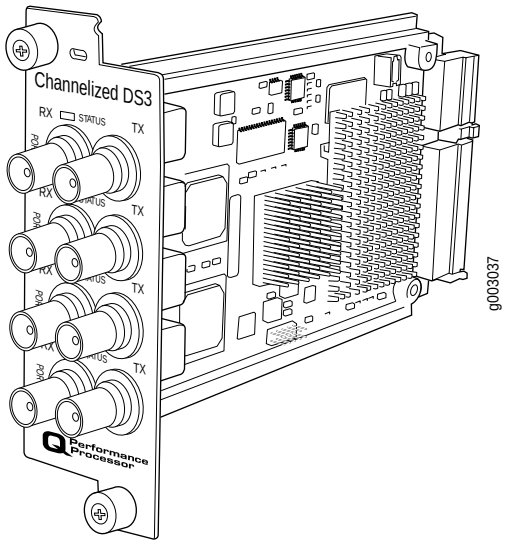
Channelized DS-3 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Four DS-3 ports ■ Power requirement: 0.31 A/48 V = 14.9 W ■ Supports up to 28 T1 channels per port ■ Data service unit (DSU) functionality
Software release	■ JUNOS 4.2 and later
Hardware features	■ Each T1 channel supports a single High-level Data Link Control (HDLC) framer that can be configured for speeds ranging from DS-0 (64 Kbps) through full T1 (1.54 Mbps) ■ Predictable throughput on all ports at 1.54 Mbps, full-duplex ■ Rate limiting on input and output ■ Packet buffering, Layer 2 parsing
Software features	■ DS-3 alarm and event counting and detection ■ DS-3 diagnostics and loopback control ■ B3ZS line encoding ■ M13 or C-bit parity ■ DS-3 SNMP support (DS-3 MIB) ■ Per-packet counts and byte counts ■ Local and remote loopback testing ■ Encapsulations—Cisco HDLC, Frame Relay, MPLS CCC, Point-to-Point Protocol (PPP)

Cables and connectors	■ Custom 10 ft/3.05 m posilock to BNC male cable, separate TX and RX
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Bit error rate (BER) ■ Equipment failure (Does not affect service) ■ Excessive zeros (EXZ) ■ Far-end Block Error ■ Frame error ■ Idle code, Idle received ■ Line code violation (LCV) ■ Local and remote loopback ■ Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Yellow alarm bit (X-bit) disagreements

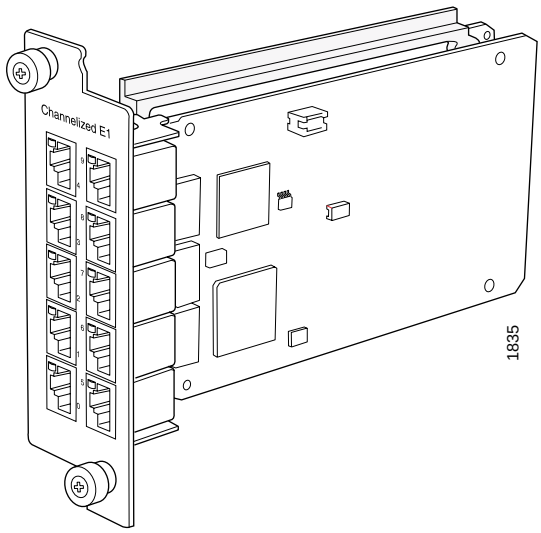
Channelized DS-3 QPP PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Four DS-3 ports ■ Power requirement: 0.38 A/48 V = 18.0 W ■ Q Performance Processor (QPP) enables multilevel channelization, quality of service (QoS), and extensive instrumentation ■ Supports up to 28 T1 channels per port ■ Supports up to 24 DS-0 channels per T1 channel ■ Data service unit (DSU) functionality
Software release	■ JUNOS 5.6 and later
Hardware features	■ Each T1 channel supports a single HDLC framer that can be configured for speeds ranging from DS-0 (64 Kbps) through full T1 (1.54 Mbps) ■ Predictable throughput on all ports at 1.54 Mbps, full-duplex ■ Rate limiting on input and output ■ Packet buffering, Layer 2 parsing
Software features	■ DS-3 alarm and event counting and detection ■ DS-3 diagnostics and loopback control ■ B3ZS line encoding ■ M13 or CBIT parity ■ DS-3 SNMP support (DS-3 MIB) ■ Supports Clear Channel DS-3 ■ Supports the following subrate DS-3 formats: ▪ Kentrox ▪ Adtran ▪ Verilink ▪ Digital Link ▪ Larscom ■ Local and remote loopback testing ■ Eight programmable queues per channel, 4096 queues total ■ Controller abstraction enables separate interface and channel configuration ■ Encapsulations—Cisco HDLC, Frame Relay, MPLS CCC, MPLS TCC, Point-to-Point Protocol (PPP)

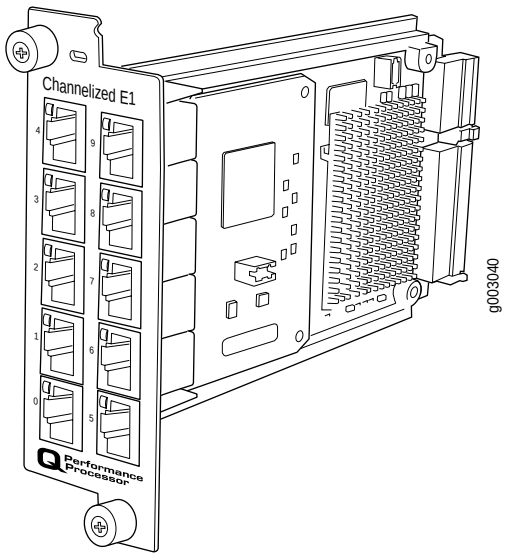
Cables and connectors	■ Standard DS-3 BNC coaxial cable interfaces
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Simultaneous Bit Error Rate Testing (BERT) sessions ■ Random Error Detection (RED) ■ Weighted Random Error Detection (WRED) ■ Equipment failure (Does not affect service) ■ Excessive zeros (EXZ) ■ Far-end Block Error ■ Frame error ■ Idle code, Idle received ■ Line code violation (LCV) ■ Local and remote loopback ■ Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Parity bit (P-bits) disagreements ■ Path parity error ■ Yellow alarm bit (X-bits) disagreements
Instrumentation (Counters)	■ Layer 2 per-queue and per-channel packet and byte couters ■ Layer 3 counters

Channelized E1 PIC



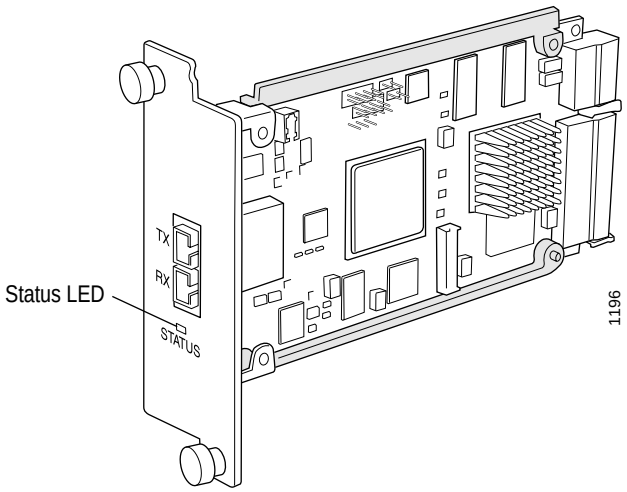
Description	■ Single-wide PIC that occupies one PIC slot ■ 10 E1 ports ■ Power requirement: 0.15 A/48 V = 7.2 W ■ Supports up to 24 NxDS-0 channels per port ■ DSU functionality
Software release	■ JUNOS 5.4 and later
Hardware features	■ Ports configurable as clear channel E1 interfaces with 2.048-Mbps connectivity ■ Rate limiting on input and output ■ Packet buffering, Layer 2 parsing
Software features	■ Support for four data-link connection identifiers (DLCIs) per logical customer channel ■ Supports unframed E1 G.703 or G.704 framing modes ■ Supports HDB3 line coding ■ CRC4 configurable ■ Per-packet counts and byte counts ■ Local and remote loopback testing ■ Encapsulations—Cisco HDLC, Frame Relay, MPLS CCC, PPP
Cables and connectors	■ 128-ohm RJ-48C
LEDs	One bicolor per E1 port: ■ Off—Port not enabled ■ Green—Physical E1 link is up; individual subchannels can be down ■ Red—Physical E1 link is down
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Loss of Frame (LoF) ■ Out of Frame (OoF) ■ Failed Signal Rate (FSR)

Channelized E1 QPP PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ 10 E1 ports ■ Power requirement: 0.15 A/48 V = 7.2 W ■ Q Performance Processor (QPP) enables multilevel channelization, quality of service (QoS), and extensive instrumentation ■ Supports up to 24 NxDS-0 channels per port ■ Data service unit (DSU) functionality
Software release	■ JUNOS 5.6 and later
Hardware features	■ Ports configurable as clear channel E1 interfaces with 2.048-Mbps connectivity ■ Rate limiting on input and output ■ Packet buffering, Layer 2 parsing
Software features	■ Support for four data-link connection identifiers (DLCIs) per logical customer channel ■ Supports unframed E1 G.703 or G.704 framing modes ■ Supports HDB3 line coding ■ CRC4 configurable ■ Local and remote loopback testing ■ Eight programmable queues per channel, 4096 queues total ■ Controller abstraction enables separate interface and channel configuration ■ Encapsulations—Cisco HDLC, Frame Relay, MPLS CCC, MPLS TCC, PPP
Cables and connectors	■ 120-ohm RJ-48C
LEDs	One bicolor per E1 port: ■ Off—Port not enabled ■ Green—Physical E1 link is up; individual subchannels can be down ■ Red—Physical E1 link is down
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Loss of Frame (LoF) ■ Out of Frame (OoF) ■ Failed Signal Rate (FSR) ■ Random Error Detection (RED) ■ Weighted Random Error Detection (WRED) ■ Simultaneous Bit Error Rate Testing (BERT) sessions
Instrumentation (Counters)	■ Layer 2 per-queue and per-channel packet and byte couters ■ Layer 3 counters

Channelized OC-12 PIC



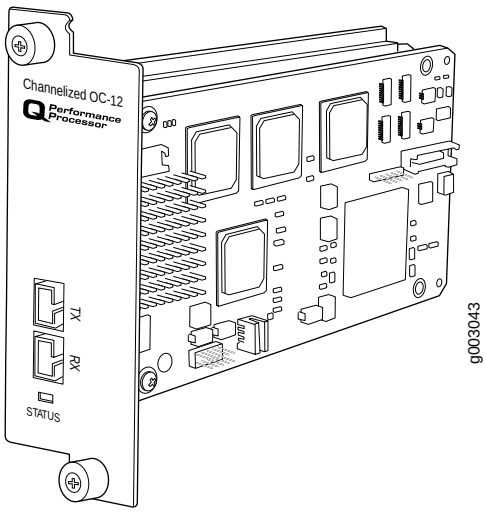
Description	■ Single-wide PIC that occupies one PIC slot ■ One OC-12 port ■ Power requirement: 0.23 A/48 V = 10.8 W ■ Supports up to 12 DS-3 channels per PIC ■ Supports IP version 4 (IPv4) unicast and multicast as well as MPLS, IS-IS, OSPF, and BGP ■ Optical interface support—See Table 4
Software release	■ JUNOS 4.1 and later
Hardware features	■ ASIC-based, high-performance throughput on all ports ■ Integrated DSU functionality with subrate and scrambling support for each DS-3 channel ■ Per-DS-3 class-of-service support ■ Dual-router SONET Automatic Protection Switching (APS) ■ Rate policing on input for each DS-3 channel ■ Per-DS-3 rate shaping on output ■ Packet buffering, Layer 2 parsing
Software features	■ M13/C-bit parity encoding ■ Full instrumentation per DS-3 channel ■ DS-3 diagnostics and loopback control ■ DS-3 alarm and event counting and detection ■ DS-3 far-end alarm and control (FEAC) channel support ■ Encapsulations—Cisco HDLC, Frame Relay, CCC, PPP
Cables and connectors	■ Duplex SC connector (TX and RX); single-mode fiber
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure

Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ BERT functionality on PIC (only one DS-3 channel can be set in BERT mode, while remaining channels transmit and receive normal traffic) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Equipment failure (Does not affect service) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Block Error (FEBE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Frame error ■ Idle code, Idle received ■ Loss of Frame (LOF), Loss of Pointer (LOP-P), Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P) ■ Yellow alarm bit (X-bit) disagreements

Table 4: Optical Interface Support for Channelized OC-12 PICs

PIC Type	Single-Mode Intermediate Reach
Channelized OC-12	
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)
Wavelength	1274 through 1356 nm
Average launch power	–15 through –8 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–28 dBm

Channelized OC-12 QPP PIC



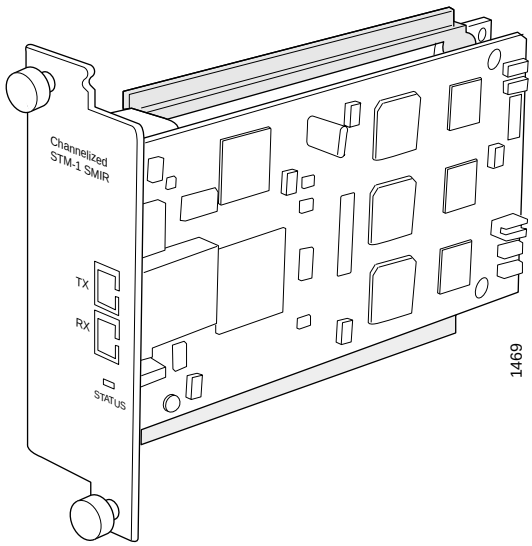
Description	■ Single-wide PIC that occupies one PIC slot ■ One OC-12 port ■ Power requirement: 0.52 A/48 V = 25.0 W ■ Q Performance Processor (QPP) enables multilevel channelization, quality of service (QoS), and extensive instrumentation ■ Supports up to 12 DS-3 channels per PIC ■ Supports up to 336 DS-1 channels per PIC ■ Supports STS-12c ■ Supports up to 4 STS-3c channels per PIC ■ Supports up to 12 STS-1 channels per PIC ■ Supports IP version 4 (IPv4) unicast and multicast as well as MPLS, Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), and Border Gateway Protocol (BGP) ■ Optical interface support—see Table 5 on page 19
Software release	■ JUNOS 5.6 and later
Hardware features	■ ASIC-based, high-performance throughput on all ports ■ Integrated DSU functionality with subrate and scrambling support for each DS-3 channel ■ Per-DS-3 class-of-service support ■ Rate policing on input for each DS-3 channel ■ Per-DS-3 rate shaping on output ■ Packet buffering, Layer 2 parsing
Software features	■ M13/C-bit parity encoding ■ Full instrumentation per DS-3 channel ■ DS-3 diagnostics and loopback control ■ DS-3 alarm and event counting and detection ■ DS-3 far-end alarm and control (FEAC) channel support ■ Eight programmable queues per channel, 4096 queues total ■ Controller abstraction enables separate interface and channel configuration ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ Duplex SC connector (TX and RX); single-mode fiber
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure

Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Simultaneous Bit Error Rate Testing (BERT) sessions ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Random Error Detection (RED) ■ Weighted Random Error Detection (WRED) ■ Equipment failure (Does not affect service) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Block Error (FEBE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Frame error ■ Idle code, Idle received ■ Loss of Frame (LOF), Loss of Pointer (LOP-P), Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Parity bit (P-bits) disagreements ■ Path parity error ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P) ■ Yellow alarm bit (X-bits) disagreements
Instrumentation (Counters)	■ Layer 2 per-queue and per-channel packet and byte couters ■ Layer 3 counters

Table 5: Optical Interface Support for Channelized OC-12 QPP PICs

PIC Type	Single-mode Intermediate Reach
Channelized OC-12	
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)
Wavelength	1274 through 1356 nm
Average launch power	–15 through –8 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–28 dBm

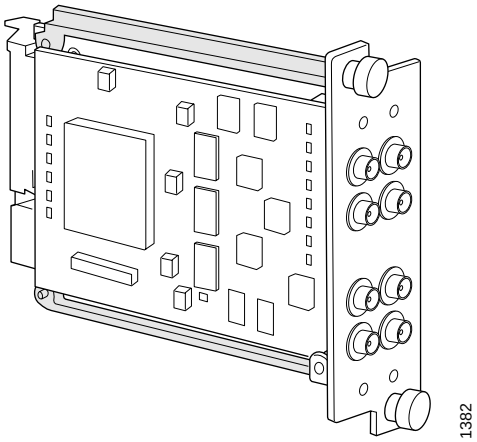
Channelized STM-1 to E1 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ One STM-1 port ■ Power requirement: 0.32 A/48 V = 15.3 W ■ Supports 63 E1 channels per port
Software release	■ JUNOS 4.4R3 and later
Hardware features	■ Each E1 channel supports a single HDLC framer that can be configured for speeds ranging from DS-0 (64 Kbps) through full E1 (2 Mbps) in 64 Kbps increments ■ Onboard DSU functionality for E1 and fractional E1 connectivity ■ Integrated support for G.703 and unframed mode and G.704 framed mode with CRC; this feature is user-configurable ■ Configurable clock source: internal or loop ■ Per-port loop timing ■ Rate limiting on input and output ■ NxE1 service with Multilink Point-to-Point Protocol (MLPPP, RFC 1990) delivered by Multilink Services PIC
Software features	■ SDH mapping: ▪ TUG3: Demultiplex each STM1 into 1 AU4 into 3 TUG3s into 63 TU12s into 63 E1s ■ E1 support: ▪ Full instrumentation per E1 channel ▪ Integrated support for G.703 unframed mode and G.704 framed mode ▪ 4-bit CRC for G.704 framed mode ▪ HDB3 coding ▪ Local E1 line loopback and remote line loopback ▪ Per-channel BERT testing ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ Single-mode fiber ■ Duplex SC connector (TX and RX)

LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Error Rate Testing (BERT) per E1 channel ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Loss of Frame (LOF), Loss of Pointer (LOP-P), Loss of Signal (LOS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P) ■ Yellow alarm bit (X-bit) disagreements

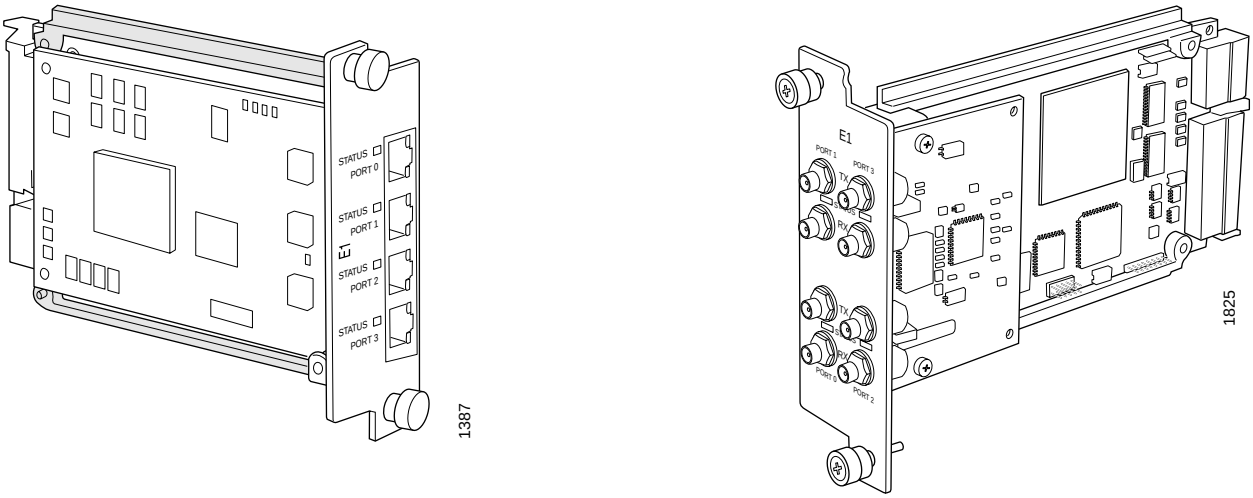
DS-3 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Four DS-3 ports ■ Power requirement: 0.47 A/48 V = 22.5 W ■ Integrated DSU interoperability with leading DSU vendors
Software release	■ JUNOS 4.1 and later
Hardware features	■ High-performance throughput on all ports at speeds up to 44.736 Mbps, full-duplex ■ C-bit framing ■ B3ZS line encoding ■ DSU scrambling support: Larscom, Digital Link, and ADC Kentrox ■ DSU subrate clocking support: Larscom and Digital Link ■ Per-port rate policing on input ■ Per-port rate shaping on output ■ Packet buffering, Layer 2 parsing
Software features	■ DS-3 functionality: ▪ C-bit framing ▪ B3ZS line encoding ■ DS-3 diagnostics and loopback control ■ DS-3 alarm and event counting and detection ■ Per-packet counts and byte counts ■ Local and remote loopback testing, as well as per-DS-3 BERT testing ■ DS-3 far-end alarm and control (FEAC) channel support ■ Encapsulations—CCC, Frame Relay, HDLC, PPP

Cables and connectors	■ Custom 10 ft/3.05 m posilock to BNC male cable ■ Four pairs of TX and RX coaxial connectors
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ BERT functionality on PIC (only one DS-3 channel can be set in BERT mode, while remaining channels transmit and receive normal traffic) ■ Equipment failure (Does not affect service) ■ Far-end Block Error (FEBE) ■ Frame error ■ Idle code, Idle received ■ Local and remote loopback ■ Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Yellow alarm bit (X-bit) disagreements

E1 PIC

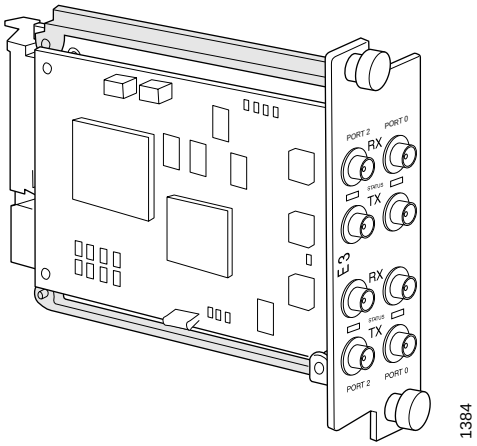


Left: E1 RJ-48; Right: E1 coaxial

Description	■ Single-wide PIC that occupies one PIC slot ■ Four E1 ports ■ Power requirement: 0.07 A/48 V = 3.41 W ■ Provides two versions: ▪ 4-port, 120-ohm, RJ-48 ▪ 4-port, 75-ohm, coax ■ Onboard DSU functionality for E1 connectivity
Software release	■ JUNOS 4.1 and later
Hardware features	■ High-performance throughput on all ports at speeds up to 2.048 Mbps, full-duplex ■ Large MTUs of up to 4500 bytes ■ Per-interface diagnostics and loopback control ■ Per-interface shaping on output ■ Per-interface alarm and event counting and detection ■ HDB3 line coding ■ 4-bit cyclic redundancy check (CRC) for G.704 framed modes ■ Per-port loop timing ■ Balanced and unbalanced modes ■ Packet buffering, Layer 2 parsing
Software features	■ Integrated support for G.703 unframed mode and G.704 framed mode with CRC; this feature is user-configurable Note: The G.704 implementation supports speeds slower than 2.048 Mbps. Multiple channels within a single E1 are not supported. ■ Configurable clock source: internal or loop ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP

Cables and connectors	■ Two versions: ▪ Four RJ-48 connectors (one for each port) ▪ Custom 10 ft/3.05 m posilock to BNC male cable, separate TX and RX coaxial connectors
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Bipolar Violations ■ Excessive Zeros ■ Far-end Block Errors (FEBE, E-bit errors) ■ Loss of Frame (LOF), Loss of Signal (LOS) ■ Local and remote loopback diagnostics ■ Yellow alarm bit (X-bit) disagreements

E3 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Four E3 ports ■ Power requirement: 0.47 A/48 V = 22.5 W ■ Integrated DSU interoperability
Software release	■ JUNOS 4.1 and later
Hardware features	■ Offers high-density E3 (34.368-Mbps) connectivity ■ High-performance throughput on all ports at speeds up to 34.368 Mbps, full-duplex ■ Scrambling support ■ Subrate clocking support ■ Rate policing on input ■ Rate shaping on output ■ Packet buffering, Layer 2 parsing ■ Large MTUs of up to 9192 bytes
Software features	■ Supports G-751 Framing ■ E3 diagnostics and loopback control ■ E3 alarm and event counting and detection ■ DS-3 diagnostics and loopback control ■ Bit Error Rate Test (BERT); you can configure one port in BERT mode and configure remaining channels to transmit and receive normal traffic ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ Custom 10 ft/3.05 m posilock to BNC male cable, separate TX and RX
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Equipment failure (Does not affect service) ■ Frame error ■ Line code violation ■ Local and remote loopback ■ Loss of Signal (LOS) ■ Out of Frame (OOF) ■ Yellow alarm bit (A-bit) disagreements

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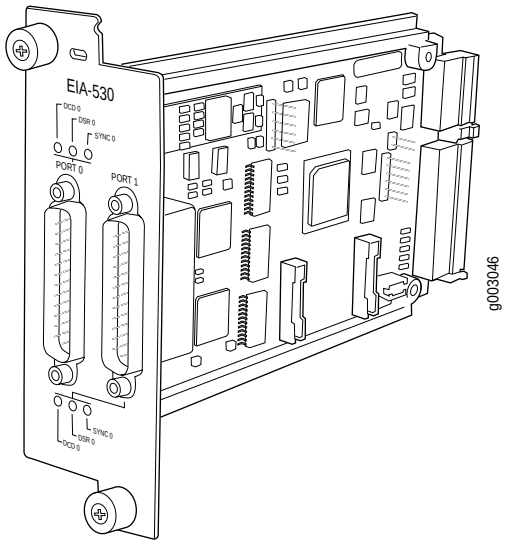
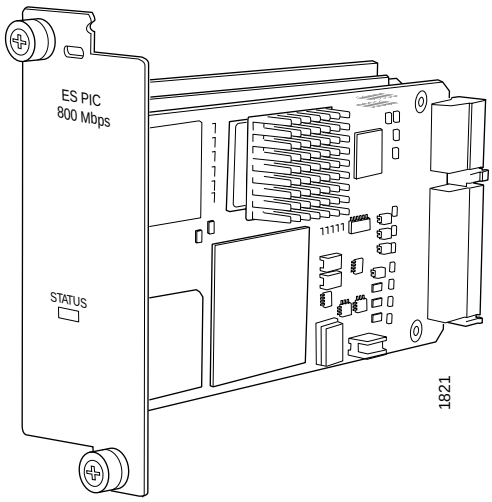
EIA-530 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Two EIA-530 serial ports ■ Power requirement: 0.07 A/48 V = 3.41 W
Software release	■ JUNOS 5.6 and later
Hardware features	■ Configured as Data Terminal Equipment (DTE) ports ■ Cryptographic resynchronization signal ■ Receives clock rates up to 16 Mbps. ■ Local, Data Communications Equipment (DCE) local, and DTE remote loopbacks

Software features	■ Supports four queues per port ■ Random Early Detection (RED) ■ Transmitter Signal Element Timing is looped from the timing received on the Transmitted Signal Element DCE. The EIA-530 PIC supports the ability to invert the Transmit Data Element. The EIA-530 PIC supports the following rates: ▪ 2.048 Mbps ▪ 2.341 Mbps ▪ 2.731 Mbps ▪ 3.277 Mbps ▪ 4.09 Mbps ▪ 5.461 Mbps ▪ 8.192 Mbps ▪ 16.384 Mbps ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ Two DB-25 male connectors (one for each port)
LEDs	Three bicolor per port: ■ Data Set Ready (DSR): ▪ Green—DSR is detected or ignored ▪ Red—DSR expected but not present ■ Data Carrier Detect (DCD): ▪ Green—DCD is detected or ignored ▪ Red—DCD expected but not present ■ Resynchronization: ▪ Green—Keepalives are being received ▪ Red—Data Terminal Ready (DTR) toggled from low to high (resynchronization pulses are being sent)
Instrumentation (Counters)	■ Per-port packet and byte couters ■ Cryptographic resynchronization counters: ▪ Number of resynchronizations initiated ▪ Time of last resynchronization

ES PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Services PIC—enhances functionality of other PICs, no interfaces of its own ■ Power requirement: 0.21 A/48 V = 10 W ■ Support for IPSec encryption, decryption, and key calculation acceleration ■ High-bandwidth encryption (in accordance with Internet Protocol Security (IPSec) standards)
Software release	■ JUNOS 5.3 and later
Hardware features	■ Extends the existing security functionality to Internet traffic at high-performance rates ■ Throughput at 800 Mbps, half duplex ■ 1000 IPSec tunnels ■ Supports MTUs of up to 3900 bytes
Software features	■ Support for IPv4 ■ Authentication hash algorithms: MD-5 and SHA-1 ■ Encryption algorithms: DES, 3-DES, and Null ■ Automated key management using Diffie-Hellman key establishment ■ Support for preshared key management ■ Encapsulating security payload (ESP) on individual packets ■ Tunnel mode IPSec encryption and decryption for data traffic ■ Static and dynamic security associations supported ■ SA lifetime configurable in seconds ■ Does not support reassembly and decryption of encrypted packets that have been previously fragmented in an IPSec tunnel
Cables and connectors	■ None
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Instrumentation (Counters)	■ Input and output bytes per tunnel ■ Total authentication failures ■ Total anti-reply failures ■ Total encryption ASIC errors per PIC

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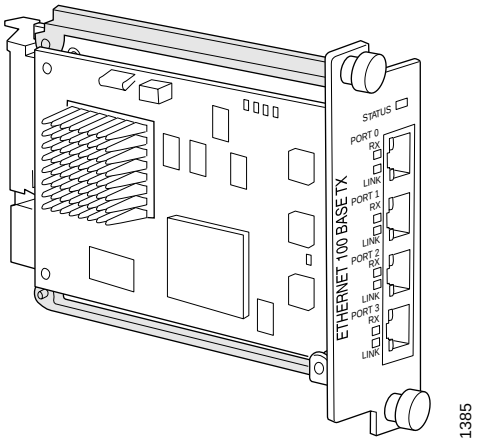
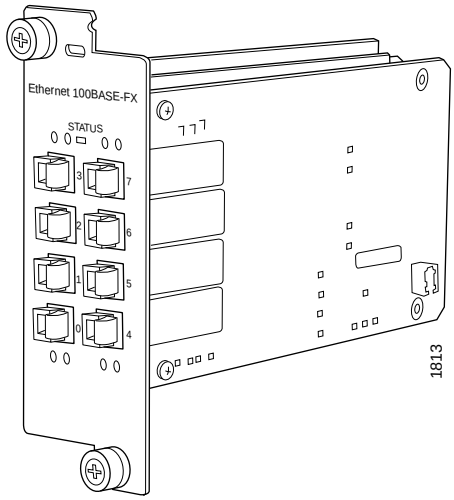
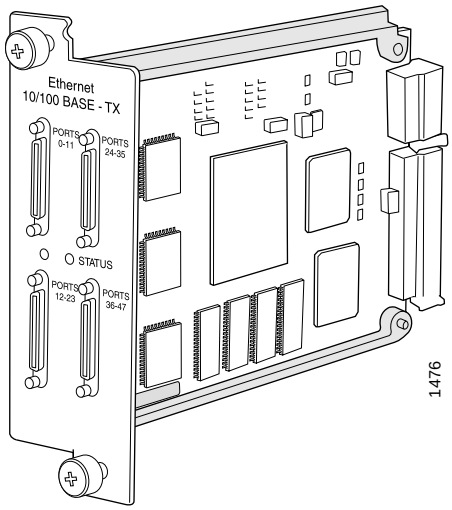
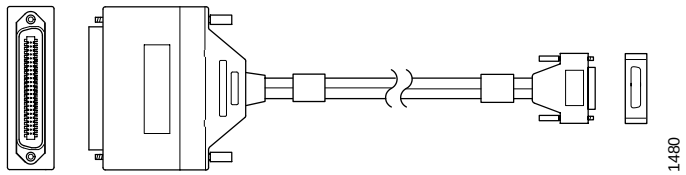
Fast Ethernet PICs





Left: 4-Port Fast Ethernet; Right: 8-Port Fast Ethernet



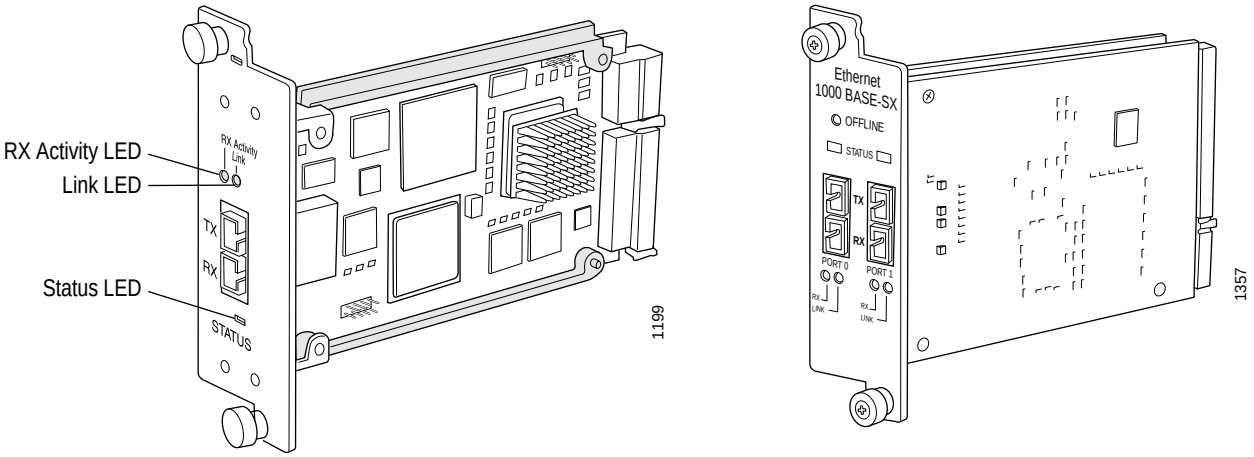


Left: 48-port Fast Ethernet; Right: VHDCI to RJ-21 Cable

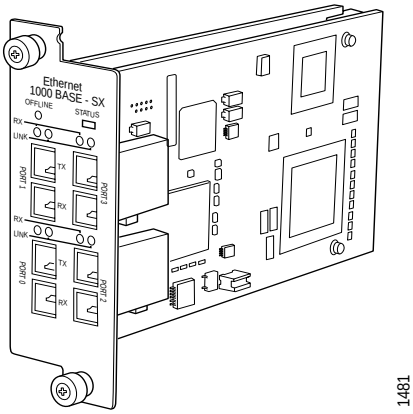
Description	■ Single-wide PIC that occupies one PIC slot ■ 4, 8, or 48 100BaseT ports ■ Power requirements: ▪ 4-port: 0.14 A/48 V = 6.8 W ▪ 8-port: 0.26 A/48 V = 2.5 W ▪ 48-port: 0.69 A/48 V = 33.3 W ■ 48-port PIC available only on M160 FPC2 Note: Each M160 router can support up to eight 48-port PICs, one per FPC2
Software release	■ 4-port: JUNOS 4.1 and later ■ 8-port: JUNOS 5.2 and later ■ 48-port: JUNOS 4.4 and later

Hardware features	■ High-performance throughput on all ports at speeds up to 100 Mbps ■ Source and destination MAC address filtering ■ RMON EtherStats packet buffering ■ 802.3 Ethernet standard compliant ■ 4-port and 8-port PICs support large MTUs of up to 4470 bytes; 48-port PIC supports MTUs of up to 1534 bytes ■ 4-port and 8-port PICs support Layer 2 parsing ■ 4-port and 8-port PICs provide two-pair, Category 5 unshielded twisted-pair connectivity through an RJ-45 connector
Software features	■ Auto sensing full-duplex and half-duplex modes ■ Virtual Router Redundancy Protocol (VRRP) support ■ 802.1Q virtual LANs (VLANs) support; 48-port PIC provides 16 VLANS per port ■ Circuit cross-connect VLAN support
Cables and connectors	**4-port and 8-port PICs:** ■ Four RJ-45 connectors (one for each port); MDI noncrossover **48-port PIC:** ■ Four Very High Density Connector Interface (VHDCI) to RJ-21 cables that connect to an RJ-45 patch panel—Category 5 compliant and 3 meters each ■ Four VHDCI connectors that service 12 10/100 ports Note: Each of the four connectors on a Fast Ethernet 48-port PIC can support a maximum of approximately 700 Mbps. However, this constitutes oversubscription. Use this PIC only in environments that can support this level of oversubscription.
LEDs	**Status LEDS, one bicolor:** ■ Off—PIC ports not enabled ■ Green—PIC is operating normally ■ Red—PIC has an error or failure **4-port and 8-port PICs have port LEDs, one pair per port:** ■ Link—If green, the port is online; no light means the port is down ■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data **The 48-port PIC does not have port LEDs. To check port status on a 48-port PIC:** 1. Locate the LCD and select MENU. 2. Choose fe pic status and press ENTER. 3. Use the arrow buttons to select the slot and PIC number. Then press ENTER to see port status. 4. Read the port numbers vertically. You will see one of three symbols: ▪ * (asterisk–equivalent to green port LED)—Port is active and receiving data ▪ – (minus sign–equivalent to flashing green port LED)—Port might be active but is not receiving data ▪ Blank—Port is not active

Gigabit Ethernet PICs



Left: 1-Port Gigabit Ethernet; Right: 2-Port Gigabit Ethernet



4-Port Gigabit Ethernet

Description	■ Single-wide PIC that occupies one PIC slot ■ Ports: ▪ One Gigabit Ethernet port on an M160-FPC1 ▪ Two Gigabit Ethernet ports on an M160-FPC2 ▪ Four Gigabit Ethernet ports on an M160-FPC2 ■ Power requirements: ▪ 1-port: 0.27 A/48 V = 13.2 W ▪ 2-port: 0.35 A/48 V = 17 W ▪ 4-port: 0.20 A/48 V = 9.7 W ■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network ■ M160 chassis supports seven types of Gigabit Ethernet PICs: ▪ 1-port SX or LX, available only for an M160 FPC1 ▪ 1-port, long haul (LH) (70 km), available only for an M160 FPC1 ▪ 2-port, SX or LX, available only for an M160 FPC2 ▪ 4-port, available only for an M160 FPC2 ■ Optical interface support—See Table 6 on page 36 Note: If you use multiple 4-port Gigabit Ethernet PICs in a single FPC, performance rates at high levels can cause oversubscription. Use this PIC in environments that can support oversubscription.
Software release	■ 1-port: JUNOS 4.0 and later ■ 2-port: JUNOS 4.1 and later ■ 4-port: JUNOS 5.0 and later
Hardware features	■ High-performance throughput on all ports at speeds up to 1 Gbps ■ Auto negotiation between Gigabit Ethernet circuit partners ■ Full-duplex mode ■ Large MTUs of up to 9192 bytes ■ In addition, the 4-port Gigabit Ethernet PIC supports the following features: ▪ 1000Base-SX functionality for each port ▪ 64 source MAC address filters per port ▪ 960 destination MAC filters per port ▪ Maximum MTU of 4500 bytes
Software features	■ Virtual Router Redundancy Protocol (VRRP) support ■ 802.1Q virtual LANs (VLANs) support ■ 32 source MAC address filters per port ■ 992 destination MAC filters per port ■ RMON EtherStats ■ SX, LX and LH optical interface support—See Table 6 on page 36
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	Status LEDS, one bicolor: ■ Off—PIC not enabled ■ Green—PIC is operating normally Note: A normal status appears on the 4-port Gigabit Ethernet PIC's LED when at least one port is online ■ Red—PIC has an error or failure Port LEDs, one pair per port: ■ Link—If green, the port is online; no light means the port is down ■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data

Table 6: Optical Interface Support for Gigabit Ethernet PICs

PIC Type	SX Transceiver	LX Transceiver	Long Haul Transceiver (LH)
Gigabit Ethernet			
Optical interface	656-ft/200-m reach on 62.5/125 micrometer multimode fiber (MMF)	6.2-mile/10-km reach on 9/125 micrometer single-mode fiber (SMF)	49.5-mile/70-km reach on 8.2 micrometer SMF
	1640-ft/500-m reach on 50/125 micrometer MMF	1804.5-ft/550-m reach on 62.5/125 and 50/125 micrometer MMF	
Wavelength	830 through 860 nm	1270 through 1355 nm	1480 through 1580 nm
Average launch power	–9.5 through –4 dBm	–11 through –3 dBm	–3 through +2 dBm
Receiver saturation	–3 dBm	–3 dBm	–3 dBm
Receiver sensitivity	–17 dBm	–19 dBm	–23 dBm (BER 1012) for SMF

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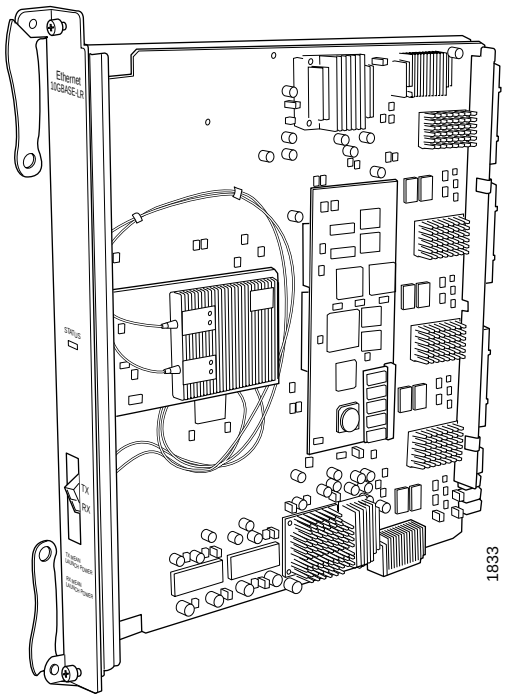
10-Gigabit Ethernet PIC

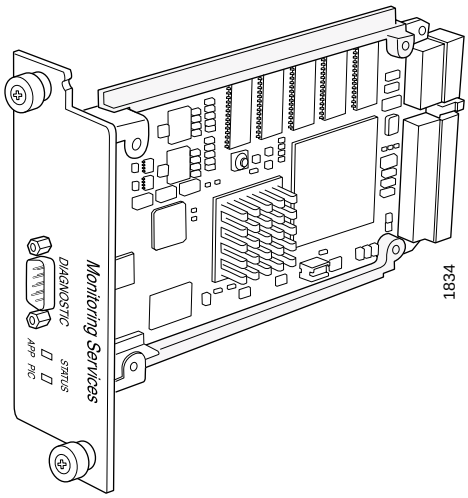


Description	■ 10-Gigabit Ethernet PIC combines features of a PIC and an FPC and occupies four PIC slots ■ Power requirement: 0.74 A/48 V = 35.5 W ■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network ■ Optical interface support—See Table 7 on page 39
Software release	■ JUNOS 5.4 and later
Hardware features	■ High-performance throughput at speeds up to 10 Gbps ■ Auto negotiation between 10-Gigabit Ethernet circuit partners ■ Full-duplex mode ■ Large MTUs of up to 9192 bytes ■ 64 source MAC address filters per port ■ 964 destination MAC filters per port
Software features	■ Virtual Router Redundancy Protocol (VRRP) support ■ 802.1Q Virtual LANs (VLANs) support ■ RMON EtherStats
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	Status LEDS, one tricolor: ■ Off—PIC not enabled ■ Green—PIC online with no alarms or failures ■ Amber—PIC online with alarms for remote failures ■ Red—PIC active with a local alarm; router has detected a failure Port LEDs, one pair per port: ■ Link—If green, the port is online; no light means the port is down ■ RX—If blinking green, the port is receiving data; if there is no light, the port might be on, but is not receiving data

Table 7: Optical Interface Support for 10-Gigabit Ethernet PICs

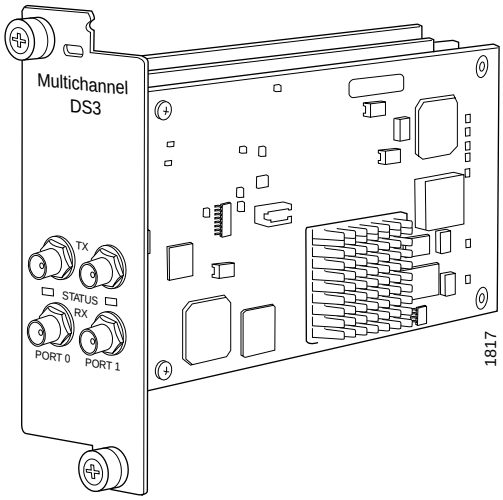
PIC Type	Long Wavelength Serial, LAN Rate, Long Reach
10-Gigabit Ethernet	
Optical interface	6.2-mile /10-km reach on micrometer single-mode fiber (SMF) with SC duplex connector
Wavelength	1290 to 1330 nm
Average launch power	–4 through 0 dBm
Receiver saturation	0 dBm
Receiver sensitivity	–12 dBm

Monitoring Services PIC



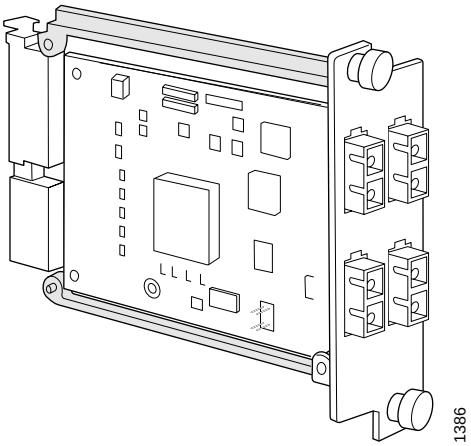
Description	■ Single-wide PIC that occupies one PIC slot ■ Available for offline traffic monitoring Note: Not for inline flow monitoring ■ Power requirement: 0.19 A/48 V = 9 W ■ Monitors IPv4 packets on OC-3, OC-12, and OC-48 SONET links ■ Support for collecting and exporting cflowd records
Software release	■ JUNOS 5.4 and later
Hardware features	■ Throughput speeds up to 500 Mbps, determined by packet size ■ Monitors up to 500 Mbps of unidirectional or 250 Mbps of bidirectional traffic ■ Supports MTUs of up to 4474 for SONET interfaces
Software features	■ Load distribution across multiple PICs ■ Cflowd v5 support ■ Provides start and end times of each export ■ Encapsulations—Cisco HDLC, PPP ■ Supports firewall filtering and filter-based forwarding
Cables and connectors	■ DB-9 diagnostic serial console port
LEDs	Status LED, one tricolor: ■ Off—PIC is offline and it is safe to remove from the chassis ■ Green—PIC is operating normally ■ Amber—PIC is initializing ■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis Application LED, one tricolor: ■ Off—Flow collector is not running ■ Green—Flow collector is running under acceptable load ■ Amber—Flow collector is overloaded

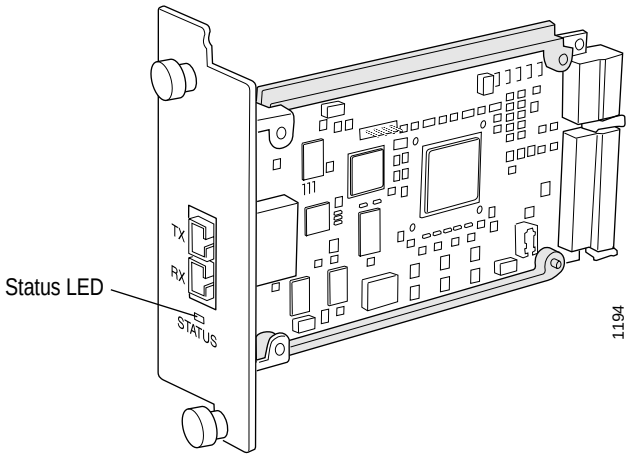
Multichannel DS-3 PIC



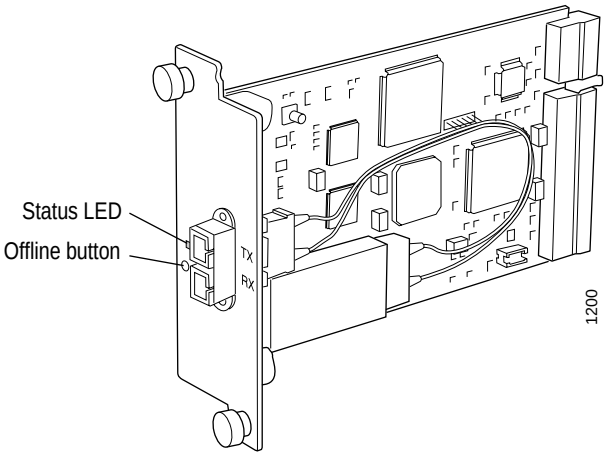
Description	■ Single-wide PIC that occupies one PIC slot ■ Two DS-3 ports ■ Power requirement: 0.31 A/48 V = 14.9 W ■ Supports up to 128 logical customer channels per DS-3 port
Software release	■ JUNOS 5.2 and later
Hardware features	■ Support for NxT1 by interoperating with the Multilink Services PIC, using MLPPP and MLFR protocols ■ Onboard DSU functionality
Software features	■ Support for four data-link connection identifiers (DLCIs) per logical customer channel ■ DS-3 alarm and event counting and detection ■ DS-3 diagnostics and loopback control ■ DS-3 framing: M13, C-bit ■ T1 framing: super frame (SF) and extended super frame (ESF) ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ Custom 10 ft/3.05 m posilock to BNC male cable, separate TX and RX
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with local alarm; router has detected a failure
Alarms, errors, and events	■ Far-end Block Error (FEBE) ■ Parity bit (P-bit) disagreements ■ Path priority error ■ Alarm Indication Signal (AIS) ■ Loss of Signal (LoS) ■ Out of Frame (OoF) ■ Yellow alarm ■ AIS Received ■ Simultaneous BERT functionality ■ Idle received ■ Local and remote loopback

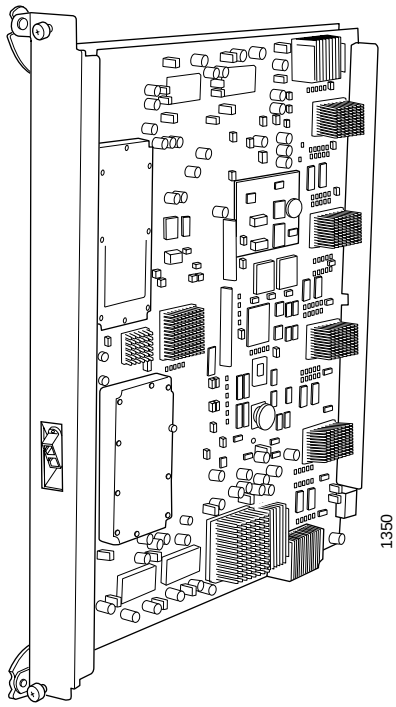
SONET / SDH PICs





Left: SONET / SDH OC-3; Right: SONET / SDH OC-12 1-Port





Left: SONET / SDH OC-48; Right: SONET / SDH OC-192

Description	■ OC-3, OC-12, and OC-48 PICs are single-wide PICs that occupy one PIC slot ■ OC-192 PIC combines features of a PIC and an FPC and occupies four PIC slots ■ Supports OC-3, OC-12, OC-48, and OC-192 line speeds ■ SONET/SDH OC-48 PIC available only on an M160 FPC2 ■ Power requirements: ▪ OC-3: 0.49 A/48 V = 23.7 W ▪ OC-12: 0.23 A/48 V = 10.8 W ▪ OC-48: 0.86 A/48 V = 41.4 W ▪ OC-192: 3.0 A/48 V = 144 W ■ Perform multiplexing and demultiplexing ■ Optical interface support—See Table 8 on page 44
Software release	■ JUNOS 4.0 and later
Hardware features	■ High-performance throughput on all ports with advanced services and features enabled ■ High-density interface concentration ■ No input buffering delay ■ Rate policing on input ■ Rate shaping on output ■ No input buffering delay on PIC ■ Packet buffering, Layer 2 parsing
Software features	■ SONET/SDH framing ■ Alarm and event counting and detection ■ Dual-router automatic protection switching (APS) and MPLS fast reroute protection ■ Encapsulations—CCC, Frame Relay, HDLC, PPP
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P)

Table 8: Optical Interface Support for SONET/SDH PICs

PIC Type		
OC-3/STM-1	**Single-Mode Intermediate Reach**	**Multimode**
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 1.2 miles/2 km)
Wavelength	1260 through 1360 nm	1270 through 1380 nm
Average launch power	–15 through -8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–30 dBm
OC-12/STM-4		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC duplex connector (maximum distance 546.8 yards/500 m)
Wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm
OC-48/STM-16	**Single-Mode Short Reach**	**Single-mode Long Reach**
Optical interface	Single-mode, short reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 1.24 miles/2 km)	Single-mode, 1500 nm long reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 49.71 miles/80 km)
Wavelength	1266 through 1360 nm	1500 through 1580 nm
Average launch power	–10 through –3 dBm	–2 through + 3 dBm
Receiver saturation	–3 dBm	–9 dBm
Receiver sensitivity	–18 dBm	–28 dBm
OC-192/STM-64	**Single-Mode Short Reach (SR 2)**	**Single-Mode Very Short Reach (VSR 1)**
Optical interface	Single-mode, short reach (Bellcore GR-253 compliant) with SC duplex connector (maximum distance 12.4 miles/20 km)	Single-mode, short reach compatible with 12-ribbon multimode fiber with MTP connector (maximum distance 984.25 feet/300 m)
Wavelength	1530 through 1565 nm	830 through 860 nm
Average launch power	–4 through 0 dBm	–10 through –3 dBm
Receiver saturation	–3 dBm	–3 dBm
Receiver sensitivity	–14 dBm	–16 dBm
OC-192/STM-64	**Single-Mode Long Reach (LR 1)**	
Optical interface	Single-mode, long reach (Bellcore GR-1377 compliant) with SC duplex connector (maximum distance 49.71 miles/80 km)	
Wavelength	1530 through 1565 nm	
Average launch power	+ 6 through + 8 dBm	
Receiver saturation	–10 dBm	
Receiver sensitivity	–22 dBm	

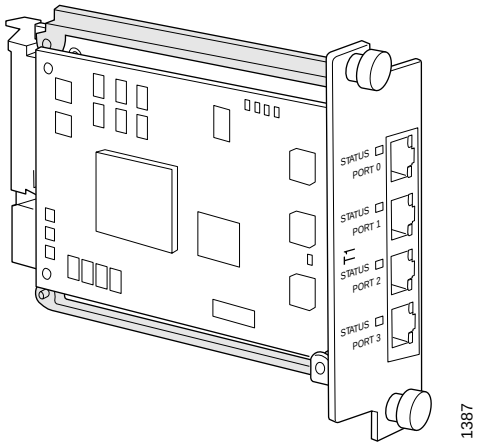
Two types of OC-192 SR-1 PICs are available. The only difference between the two is the sensitivity of the receiver optics.

If you have an OC-192 SR-1 PIC with the part number 750-002073, the amount of attenuation typically required when going back to another OC-192 is 15 db on the receiver. The RX sensitivity of this is between -13 db and -22 db.

If you have an OC-192 SR-2 PIC with the part number 750-003184, the amount of attenuation typically required when going back to another OC-192 is 5 db on the receiver. The RX sensitivity of this is between -3 db and -14 db.

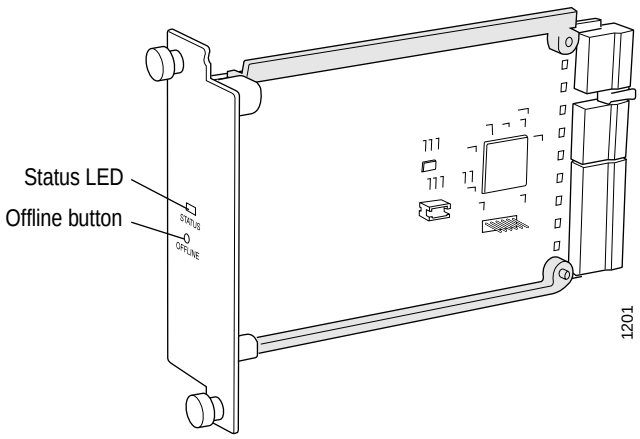
Use the JUNOS software command-line interface (CLI) to determine which PIC you have. To check the PIC part number, use the show chassis hardware command.

T1 PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Four T1 ports ■ Power requirement: 0.07 A/48 V = 3.41 W ■ Supports clear channel T1 per port (1.544 Mbps per channel)
Software release	■ JUNOS 4.1 and later
Hardware features	■ Per-port loop timing ■ Onboard DSU functionality for T1 connectivity
Software features	■ SF and ESF framing ■ B8ZS and AMI coding ■ ESF CSU counters, WRT impairments, and CRC checking ■ Local DS-1 line loopback, remote line loopback ■ Configurable clock source—internal or loop ■ Encapsulations—CCC, Cisco HDLC, Frame Relay, PPP
Cables and connectors	■ 100-ohm RJ-48 connector
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS) ■ Bipolar Violations ■ Excessive Zeros ■ Far-end Block Errors (FEBE, E-bit errors) ■ Loss of Frame (LOF), Loss of Signal (LOS) ■ Yellow alarm bit (X-bit) disagreements

Tunnel Services PIC



Description	■ Single-wide PIC that occupies one PIC slot ■ Power requirement: 0.04 A/48 V = 2 W
Software release	■ JUNOS 5.3 and later
Hardware features	■ Loopback function that encapsulates and de-encapsulates packets
Software features	■ Aggregate SONET/SDH OC-12/STM-4 tunneling bandwidth ■ IP-IP unicast tunneling ■ Generic Routing Encapsulation (GRE) unicast tunneling ■ Protocol Independent Multicast (PIM) sparse mode unicast tunneling
Cables and Connectors	None
LEDs	One tricolor: ■ Off—PIC not enabled ■ Green—PIC online with no alarms or failures ■ Amber—PIC online with alarms for remote failures ■ Red—PIC active with a local alarm; router has detected a failure

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Writer: Frank Reade
Editor: Stella Hackell
Illustrations: Faith Bradford
Covers and template design: Edmonds Design

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